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POWER MECHANISM FOR INDUCTION HEATING APPARATUS

Original Filed May 10, 1941

4 Sheets-Sheet 1

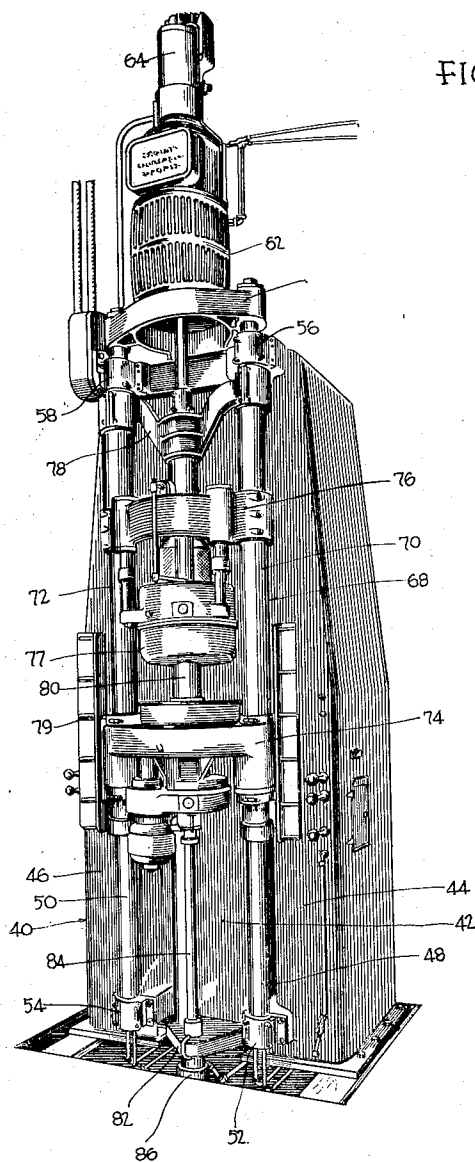


FIG. 1

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FIG. 3

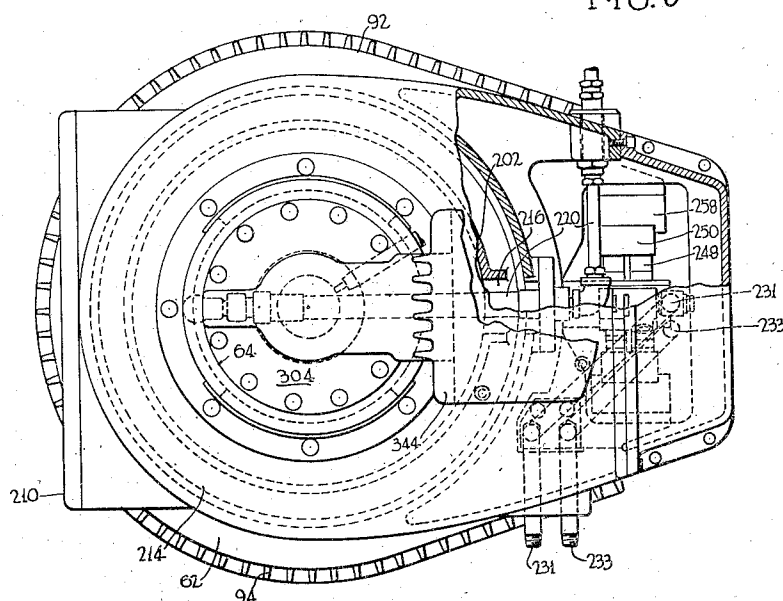
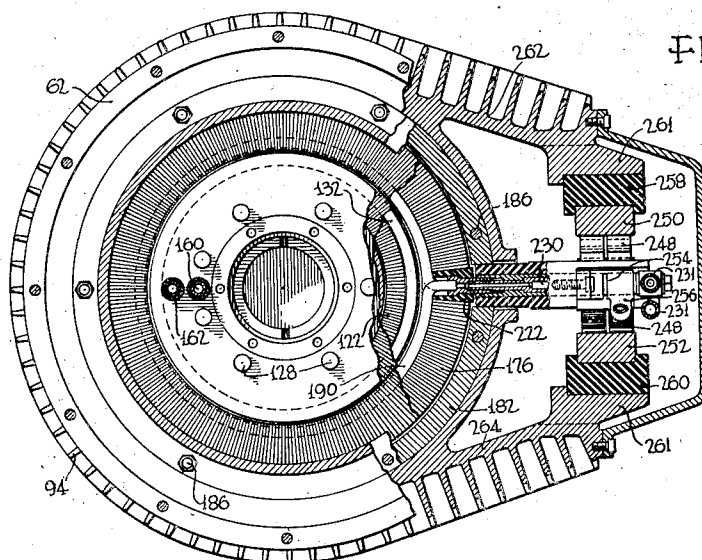


FIG. 4



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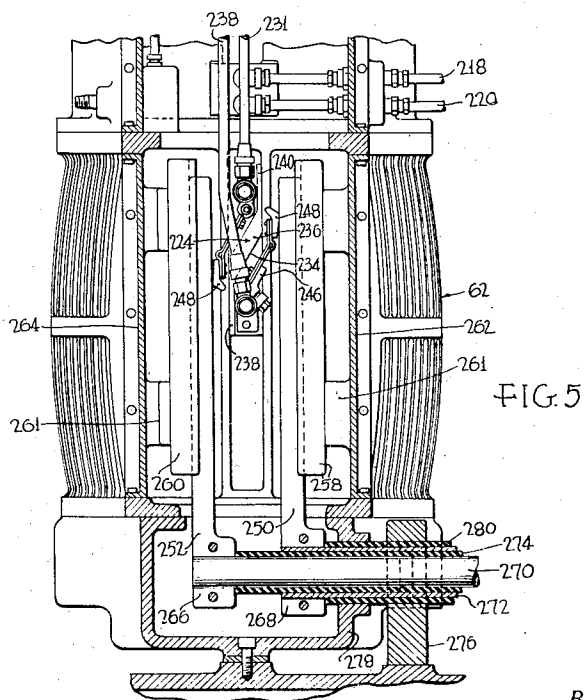


FIG. 5

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POWER MECHANISM FOR INDUCTION
HEATING APPARATUS

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Original application May 10, 1941, Serial No.
392,867. Divided and this application May 25,
1942, Serial No. 444,345

3 Claims. (Cl. 171-119)

This application is a division of my copending application Serial No. 392,867, filed May 10, 1941, for "Heat treating apparatus."

The present invention relates to apparatus for heat treating by electromagnetic induction and by quenching the surfaces of tubular and cylindrical articles, and particularly to the means for supplying high frequency energy to the inducing coil of the apparatus.

An object of this invention is to provide an electromagnetic induction heating apparatus in which the transformer has an improved construction and arrangement for connecting the transformer secondary to the heating coil, and also for connecting the transformer primary to the supply circuit.

With the above and other objects in view which will be apparent from the following detailed description, the present invention consists in certain features of construction and combinations of parts to be hereinafter described with reference to the accompanying drawings, and then claimed.

In the drawings which illustrate a suitable embodiment of the invention:

Figure 1 is a perspective view of the apparatus looking toward its front and one of its sides and illustrating the general arrangement of parts;

Figure 2 is a vertical section taken through the upper portion of the machine to illustrate the transformer mechanism constructed in accordance with one embodiment of this invention;

Figure 3 is a top plan view of the apparatus, a portion of the same being cut away to show the electrical connections;

Figure 4 is a horizontal section taken substantially on the line 6-6 of Figure 2;

Figure 5 is a rear view partly in section of the transformer.

Referring to the accompanying drawings in which like numerals refer to like parts throughout the several views and particularly to Figure 1, there is generally illustrated a heat treating apparatus comprising a rigid upright frame 40 of hollow box-like section having a vertical channel or recess 42 in the front face thereof which provides in effect spaced vertical columns 44 and 46 at either side of the forward face of the frame 40. Secured to the columns 44 and 46 is a pair of spaced upright parallel rods 48 and 50 which are secured to the frame 40 at the bottom through clamping members 52 and 54 and at the top through clamping members 56 and 58. The rods 48 and 50 extend above the top clamping members 56 and 58 and support

a cross-tie or bridging member 60 upon which a switching transformer 62 and its motivating cylinder 64 are mounted and from which the electrical conductor arbor 66 extends. The inducing head, not shown, is supported from the end and electrically connected with the arbor 66 to receive electrical current therefrom.

A carriage 68 composed of sleeves 70 and 72 telescoped with the rods 48 and 50 and connected together by the lower chuck-supporting member 74, and upper chuck-supporting member 78 and a guiding bridge 78 is arranged to be reciprocated relative to the rods 48 and 50. The workpiece 80 which is here shown as in the form of a tubular cylindrical object is held in proper position for the heat treating operations to be performed thereon between the upper and lower chuck supports 76 and 74 which carry the upper and lower clamping fixtures 77 and 79, respectively.

At the lower portion of the apparatus and between the clamping members 52 and 54 there is provided a bracket 82 which supports the quenching mechanism comprising a reciprocable quench rod 84 having at its upper end a nozzle, not shown. The elevating and retracting apparatus for the quench rod 84 extends below the bracket 82 as indicated at 86.

In the operation of the apparatus, the article or workpiece 80 is placed in position between the clamping chucks 77 and 79 and the upper chuck 77 is lowered to properly locate the article, then the quench rod 84 is raised through the workpiece 80 to position the quench head adjacent the heating head H in end-to-end relation as set forth in my copending application aforesaid. After this, the carriage 68 is elevated so that the lower end of the article is adjacent the inducing head H and then the carriage is actuated to move downwardly to progressively move the workpiece relative to the heating and quenching heads during which time the heating head is energized from the transformer mechanism to be presently described and the quenching head is supplied with quenching fluid, all as fully described in my said application.

The cap bridging member and transformer support 60 is provided with a substantially annular barrel-shaped transformer casing 92 having cooling fins 94 thereon. The lower annular flange 96 of the casing 92 is seated upon the rim 98 of an annular aperture 100 in the cap bridging member 60. The annular flange 96 additionally supports on its underside an apertured plate 102 forming, as will appear in Figure 4, together with a sleeve

104 arranged in the aperture of the plate, a support for the outer conducting sleeve 106 of the depending arbor 66. The sleeve 104 at its upper end supports a secondary 108 of a switching transformer 110 and together with the plate 102 supports an annular body 112 of radially arranged laminations of magnetic material, the latter being secured in position by the annular ridge 114 on the upper surface of the plate 102 and the annular outwardly and depending shoulder 116 arranged on the outside of the upper end of the sleeve 104 which ridge and shoulder engage complementary notches in the ends of the magnetic laminations.

Arranged concentrically above the sleeve 104 is a transformer secondary supporting sleeve 118, which cooperating with a detachable end flange member 120, is adapted to clamp a body of radially arranged laminations of magnetic material 122, the annular ridge 124 of the flange 120 and the annular dovetail shoulder 126 at the lower exterior end of sleeve 118 cooperating with complementary notches in the laminations to secure the same together. The flange 120 and sleeve 118 are secured together and in place upon the sleeve 104 by the elongated bolts 128 extending through the sleeve wall and parallel to the axis thereof.

The body of laminated magnetic material 122 is provided exteriorly with an open channel 130 in which is arranged a secondary winding of the transformer, the secondary winding as shown being constituted by three turns of four hollow rectangular cross-section conductors 132 in parallel, the terminals of which will appear on the left-hand side of Figure 2. In order to provide terminal connections to the secondary winding 132, the annular body of magnetic material 112 is interrupted as indicated on the left by a block of insulation 134 through which the lower terminal connections 136 radially extend. The sleeve 118 at the upper end and at the left as illustrated in Figure 4 is recessed to receive a shoulder 138 on the block 134 as well as a radial lug portion 140 of the annular terminal connecting sleeve 142, the lug being connected to the upper terminals 144 of the secondary winding. The connecting sleeve 142 is insulated from the sleeve 118 through the offset tubular insulating sleeve 146, the sleeve 118 and the sleeve 142 having shoulders 148 and 148 adapted to be engaged by the offset of the insulating sleeve 146 and to be held in engagement and position by an annular nut 150 threaded in the end flange 120, and bearing upon a ring of insulating material 152 located on the end of the connecting sleeve 142. The lug 140 of the connecting sleeve 142 is fitted into a recess 154 formed in the insulating block 134. To provide for water cooling of the secondary conductors the radial lug 140 and the sleeve 118, which in effect form the terminals, are provided with ports 156 and 158, which ports are connected to the hollow passageways through the conductors 132. Connections 160 and 162 sleeved in insulating material extend to the ports 156 and 158, the connection 160 and its insulation passing through the lug 140 and both connections 160 and 162 and their insulation passing through the end flange 120.

It will be observed that the sleeve 118 through the sleeve 104 makes electrical connection with the sleeve 106 forming the exterior tubular conductor of the arbor 66, while the sleeve 142 having the connecting lug 140 is provided with a

resilient sliding split sleeve connecting member 164, the same being threaded within the sleeve 142 and slidably engaging the end of a central concentric conductor 166 extending through the arbor and within a concentric layer of insulation 168. Since the conductors 166 and 106 are fixed relative to one another at a central point, such expansion or contraction as may result from the difference in cooling of the inner and outer conductors 166 and 106 will be freely allowed for by the resilient sliding engagement of the fingers 170 of the connecting sleeve 164 upon the exposed end 172 of the central conductor 166 thereby relieving any possibility of mechanical strain.

To supply the secondary with energy and to provide at the same time switching facilities for cutting on and off the supply of such energy without the use of make and break contacts, a vertically slidable primary 174 is provided in the transformer 110. The primary consists of an annulus of radially arranged laminated magnetic material 176 secured in position between spaced opposed annular ridges 178 and 180 engaging complementary notches in the ends of the laminations, the ridges being located upon the inside of the shouldered end of a primary annular surrounding sleeve 182 and an end outer flange forming member 184, the end flange member and the sleeve being secured together by longitudinally extending elongated bolts 186. The sleeve 182 with its primary is slidable snugly within the casing 92 from the position shown (see Figure 2) into the space indicated by the reference character 188 so that the tubular primary winding 190 arranged in an open channel 192 within the annular body of magnetic material 176 may be shifted from a position adjacent the secondary winding to a position adjacent the annular body of magnetic material 112, which acts to, complete the magnetic circuit with the primary body of magnetic material 176 when the primary is moved into the space 188 and out of coupling with the secondary 132 and its magnetic material 122.

In order to move the sleeve 182 and the transformer primary, a substantially annular operating yoke 196 is secured to the sleeve 182 by the bolts 186 and is in turn secured to a piston rod 198 of the transformer motivating cylinder 64, the rod being secured to the yoke by means of a split ring 200 secured in a groove 202 in the end of the rod and between interengaging annular threaded members 204 and 206 in the apertured boss 208 at the upper end of the yoke 196. The yoke 196 is provided with an inspection window 210 on its forward side adapted to align with the inspection window 212 of the upper casing member 214. The yoke is also provided with a clearance slot 216 in the rear through which extend cooling conduits 218 and 220 to the secondary cooling connections 160 and 162, the conduit 220 being formed of insulating tubular material so as to avoid short-circuiting the ungrounded terminal of the secondary winding 132.

Terminal connections to the primary winding 190 are effected through a block of insulating material 222 arranged in the annulus of magnetic material 176, the block being clamped in position in the same manner as the magnetic material between the flange ring 184 and the shoulder at the lower end of the sleeve 182. Secured to the block 222 is a sliding contact supporting block 224 projecting radially outward from the primary through a longitudinal slot 226 in the rear annular wall 228 of the casing 92. The

blocks 224 and 222 are secured together by bolts 227 and are provided with radially arranged tubular connections 230 and 232 extending to the top and bottom ends of the primary winding 190.

The insulating block 224 at its outer end is provided with a dividing partition 234 (see Figure 5), the central portion 236 of which is inclined to connect with the offset or staggered end portions 238 and 240, the partition thereby providing for insulation between the projecting ends of the connections 230 and 232. Each of the connections 230 and 232 is provided with a flange sleeve 242 anchored to the insulating block 224 by the cap screws 244 to prevent rotation. Each of the sleeve portions is provided with a lug 246 to which is secured resiliently carried contact fingers 248 adapted to ride on spaced parallel contact bars 250 and 252 (see Figures 4 and 5). The sleeve 242 has a portion thereof partially severed from the remainder as indicated at 254 (see Figure 4) and a lug 256 adapted to cooperate with the lug 246 for clamping the partially severed end of the sleeve tightly around the connections 230 and 232 extending through the sleeve. Flexible hose connections 231 and 233 for supplying coolant to the hollow primary conductor are connected to the outer ends of the tubular connections 230 and 232 which for the purpose of supplying coolant to the primary winding provide a continuous passage thereto.

It will appear that the end portions 238 and 240 of the partition 234 of the insulating block 224 form an insulating barrier between the exposed ends of the connections 230 and 232 and the adjacent spaced contact bars 250 and 252 so that flashover or electrical breakdown between the connection 230 and the bar 250 and the connection 232 and the bar 252 is assured against. As illustrated in Figures 4 and 5 the contact bars 250 and 252 are mounted upon insulating blocks 258 and 260 the latter in turn being mounted upon lugs 261 on the inside of the relatively tangential extending portions 262 and 264 of the transformer casing 92.

The lower ends of the contact bars 250 and 252 are provided with coaxial clamping members 266 and 268 (see Figure 5) adapted to securely connect with the concentric tubular conductors 270 and 272, the conductors being insulated from one another by an insulating sleeve 274 and insulated from the supporting members 276 and 278 through which they pass by a further insulating sleeve 280. The concentric conductors 270 and 272 extend into a pothead, not shown, where they are connected to power supply conductors.

As has previously been described the arbor 86 comprises the concentric conductors 196 and 198

depending from the transformer 62, the same extending to the heat treat head to supply electrical energy thereto.

Although only one embodiment or modification of the invention has been illustrated and described, it is to be understood that the invention is not limited to the single embodiment but may be embodied in various mechanical and electrical forms. As such changes in construction and arrangement of parts may be made without departing from the spirit of the invention as will be apparent to those skilled in the art, reference will be had to the appended claims for a definition of the limits of the invention.

15 What is claimed is:

1. In a heat treating apparatus, a frame, a stationary annular support mounted on said frame, a sleeve secured to the inner edge of said support and extending upwardly therefrom, a transformer including a secondary supported on the upper end of said sleeve, a current conducting arbor comprising an outer arbor member mounted on the lower end of said sleeve and extending downwardly therefrom, an inner arbor member insulated from said outer member and extending upwardly through said sleeve to a point adjacent said secondary, means electrically connecting said inner arbor member to one side of said secondary, and means electrically connecting the other side of said secondary to said sleeve and through said sleeve to said outer arbor member.

2. In a heat treating apparatus, a switching transformer comprising primary and secondary coils, one of which is movable relatively to the other, a housing for said movable coil arranged to guide the movement thereof and having a slot extending in the direction of such movement, spaced contact bars adjacent and parallel to said slot, terminals movable with said coil and extending through said slot, and contact members connected to said terminals and slidably engaging said contact bars.

3. In a heat treating apparatus, a switching transformer comprising primary and secondary coils, one of which is movable relatively to the other, a housing for said movable coil arranged to guide the movement thereof and having a slot extending in the direction of such movement, spaced contact bars adjacent and parallel to said slot, terminals movable with said coil and extending through said slot, contact members connected to said terminals and slidably engaging said contact bars, and insulating means movable with said coil and extending through said slot between said terminals and contact bars.

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